



UNIVERSITY OF
BIRMINGHAM

SCHOOL OF
PHYSICS AND
ASTRONOMY

Higgs Bosons, Birmingham and the Large Hadron Collider

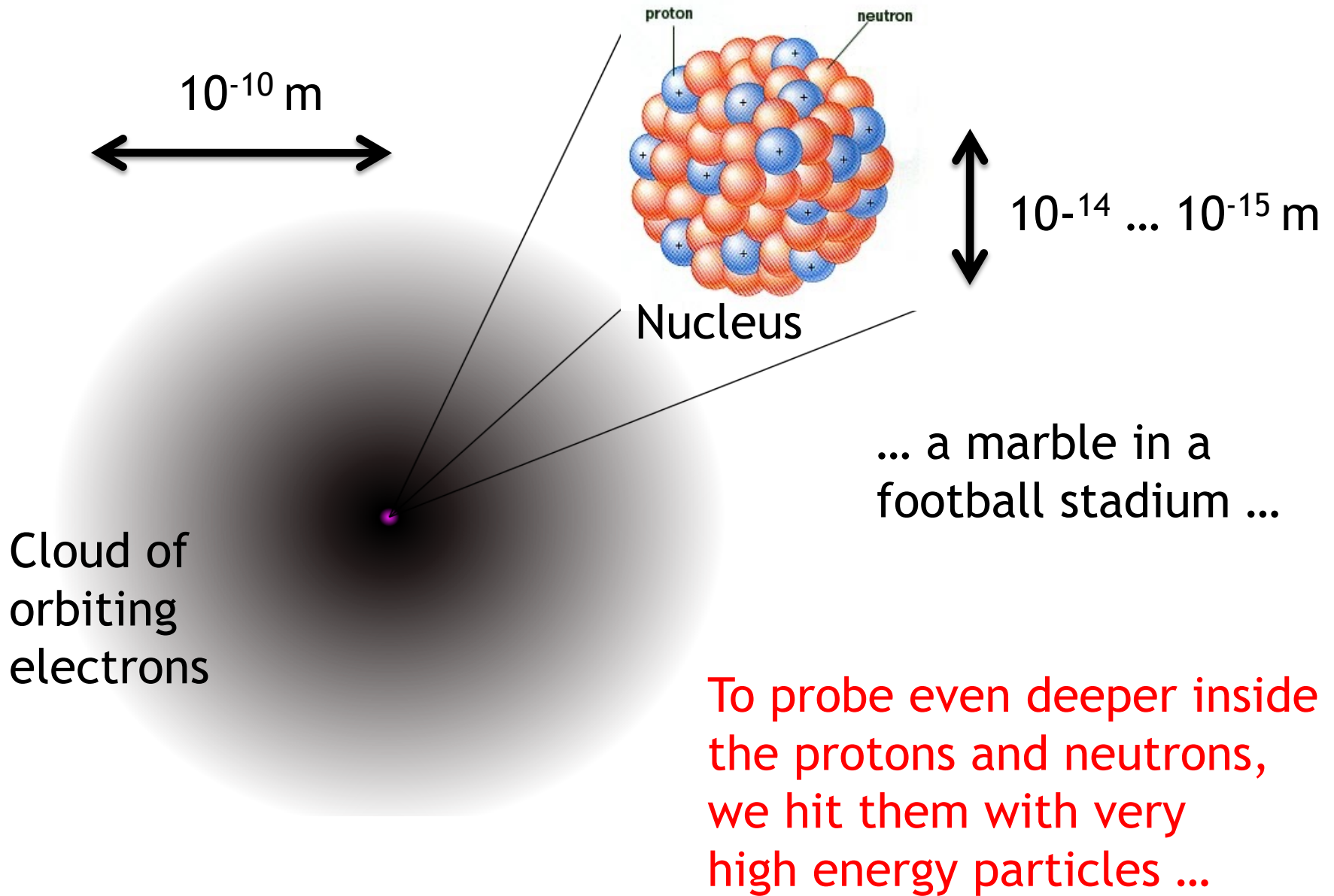
Prof Paul Newman
Particle Physics Group Leader

SHAPE YOUR **FUTURE** HERE

Physics Offer-holder Event
23 January 2021



A Modern Picture of the Atom







Geneva

... the world's
biggest physics
laboratory

Birmingham
Undergraduate
visit to CERN



THE Large Hadron Collider (LHC) at CERN

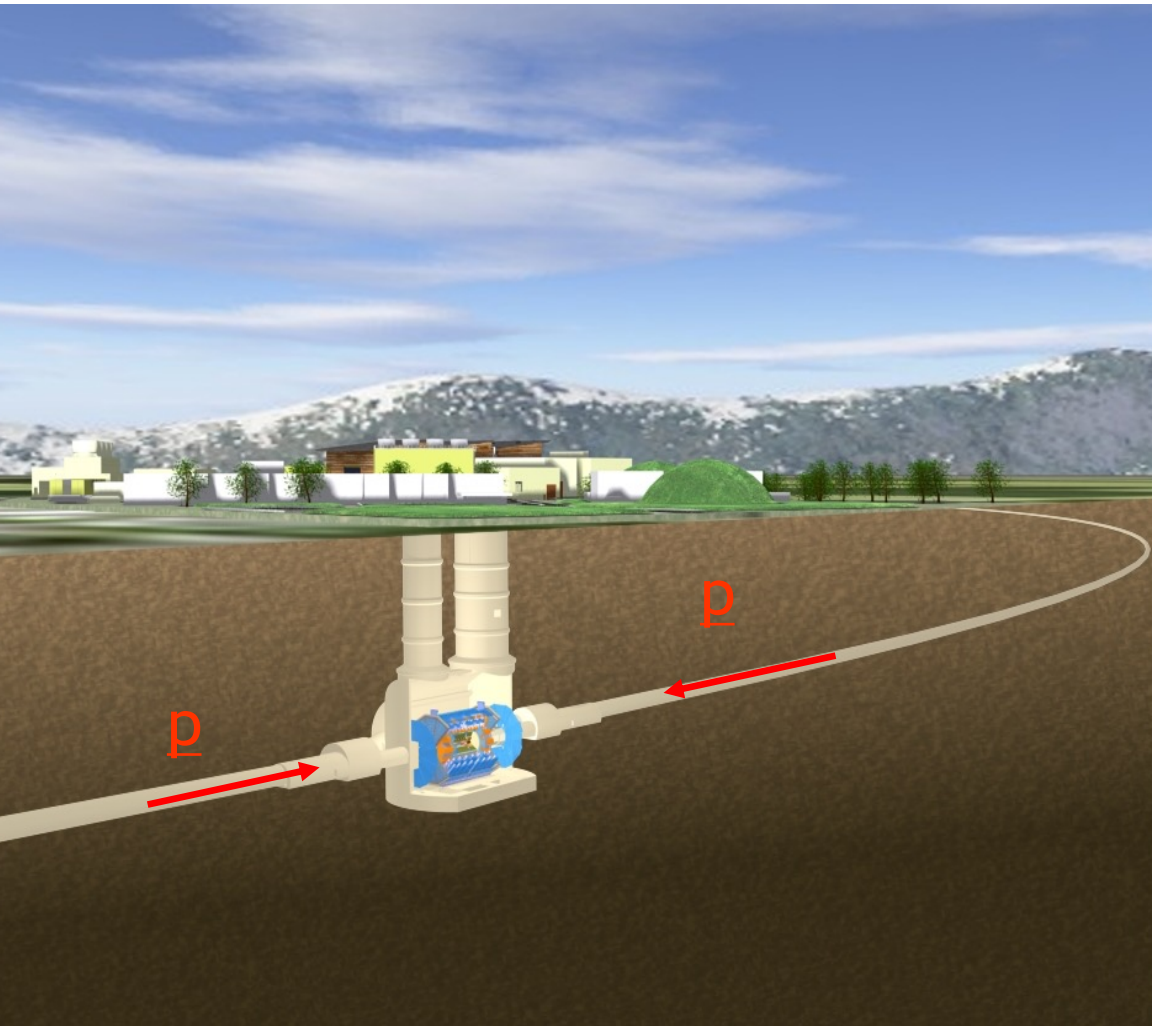
100m underground ... in a 27km long tunnel...



Birmingham has leading involvement
in ALICE, LHCb & ATLAS experiments

- accelerating protons to 0.999999996 of the speed of light
- each individual proton has 7 TeV of kinemtic energy
(as much as a flying mosquito)

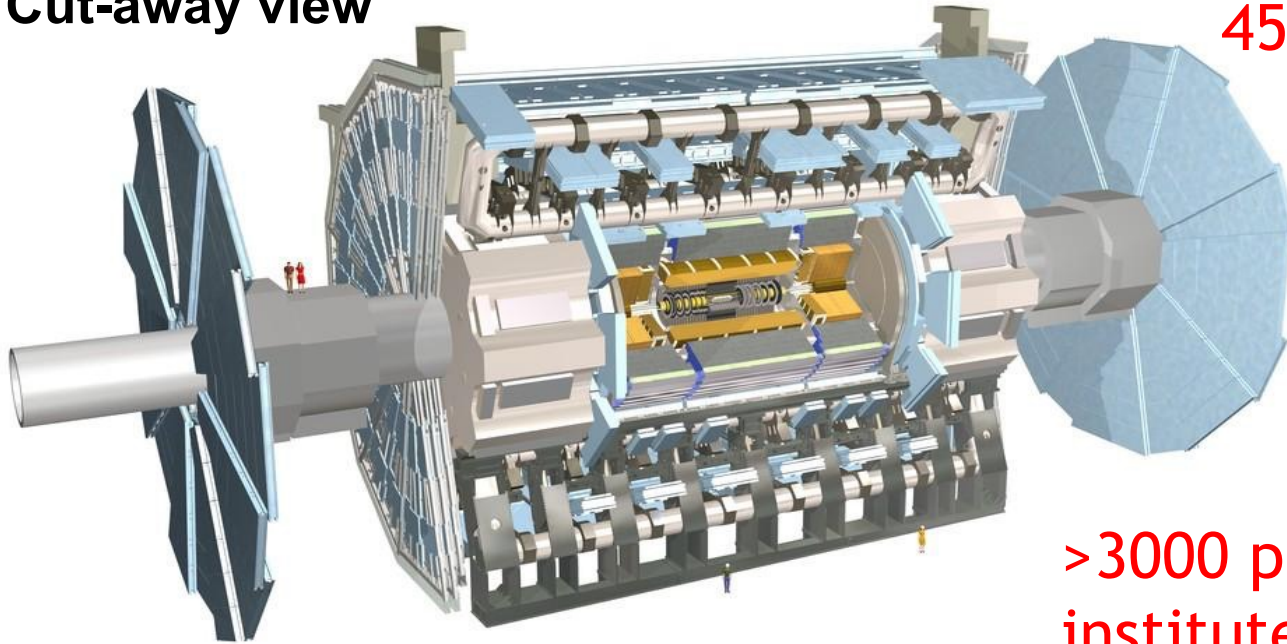
The LHC Beams and Experiments



- Each proton goes round ring 11,000 times per second.
- 10^{11} protons per bunch,
- 40 million bunch crossings per second
- About 20 collisions in every bunch crossing.
- Total stored energy of 300 MJ ... equivalent to a family car at 1000 mph

Detecting the Results of the Collisions: ATLAS

Cut-away view



45m x 25m x 25m



>3000 physicists from 174
institutes in 38 countries



Prof Dave Charlton,
Birmingham University

ATLAS
Spokesperson
2013-2017



What has the LHC Discovered?...

2013 NOBEL PRIZE IN PHYSICS

François Englert
Peter W. Higgs



THE
HIGGS
BOSON

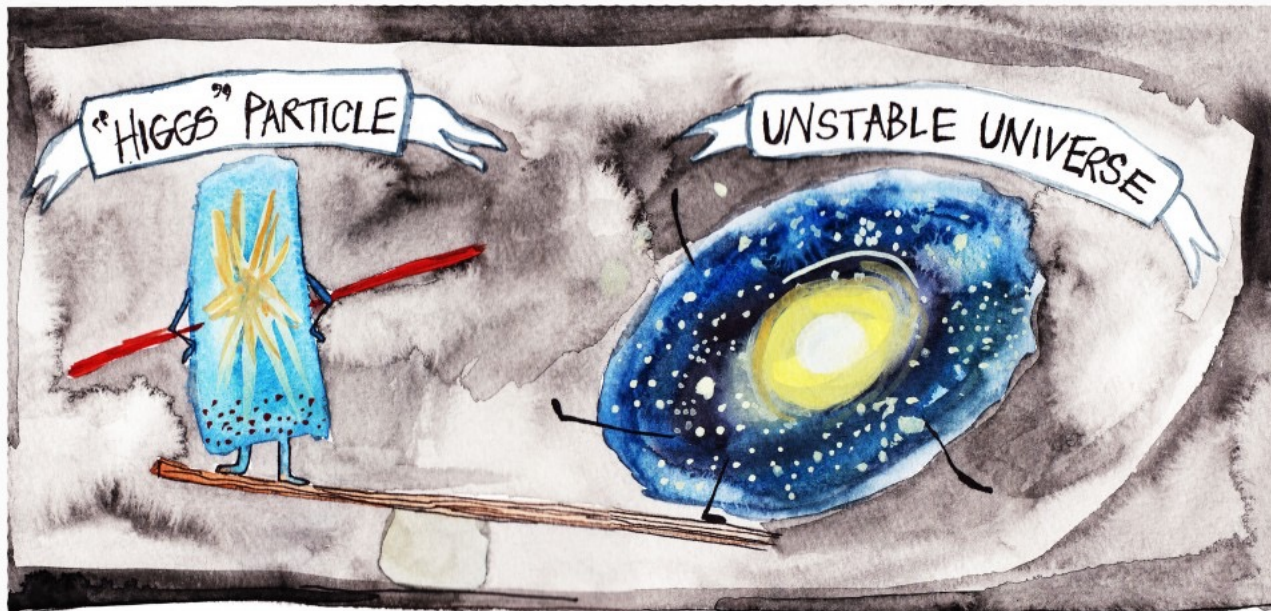


8 October 2013

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2013 to

François Englert and Peter Higgs

"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"

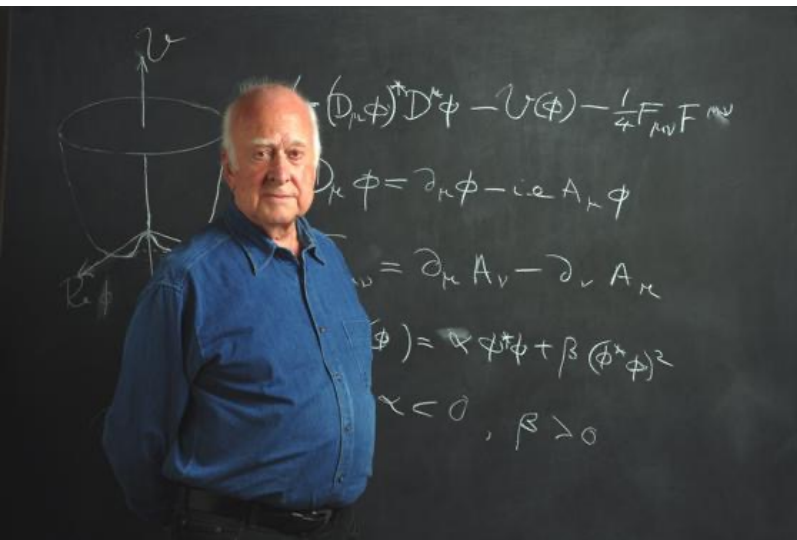


... but what
on earth is it?...

The Higgs Mechanism

For over half a century, we have had an incredibly successful theory of all known particles and forces

... except that it predicts all particles are massless!



Peter Higgs and others proposed a 'Higgs field' present throughout the entire universe

... grabbing hold of passing particles with mass

... slowing them down compared with massless particles like photons

The Higgs field is weird! Unlike force fields such as gravity:

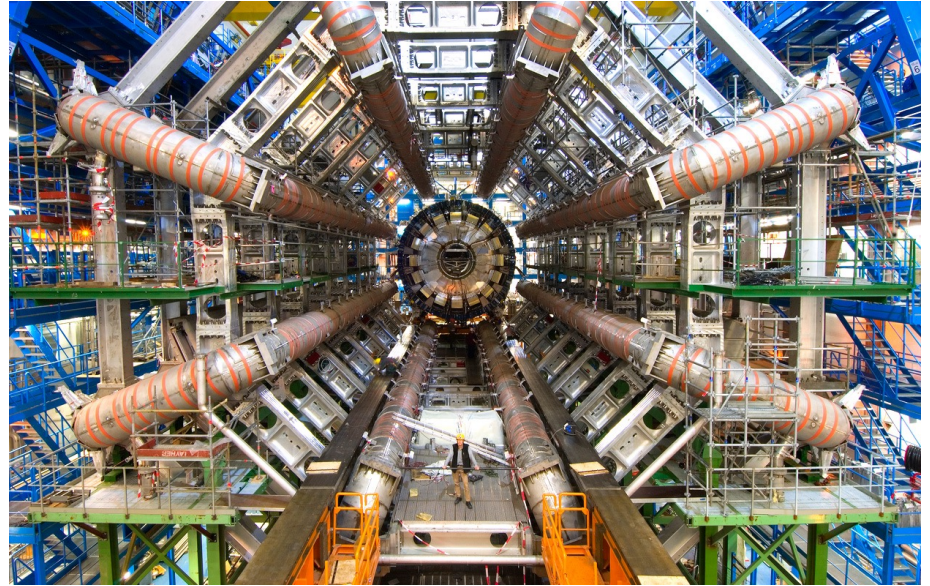
→ No preferred direction

→ No need for a source ... equally strong in vacuum of inter-galactic space as it is where you're sitting...

How to Prove the Higgs theory?

Another prediction of Higgs theory ... there should be a new particle ... a Higgs boson

Very very hard to produce
... 1 in every 10 billion collisions at the LHC



Searching for the Higgs Boson

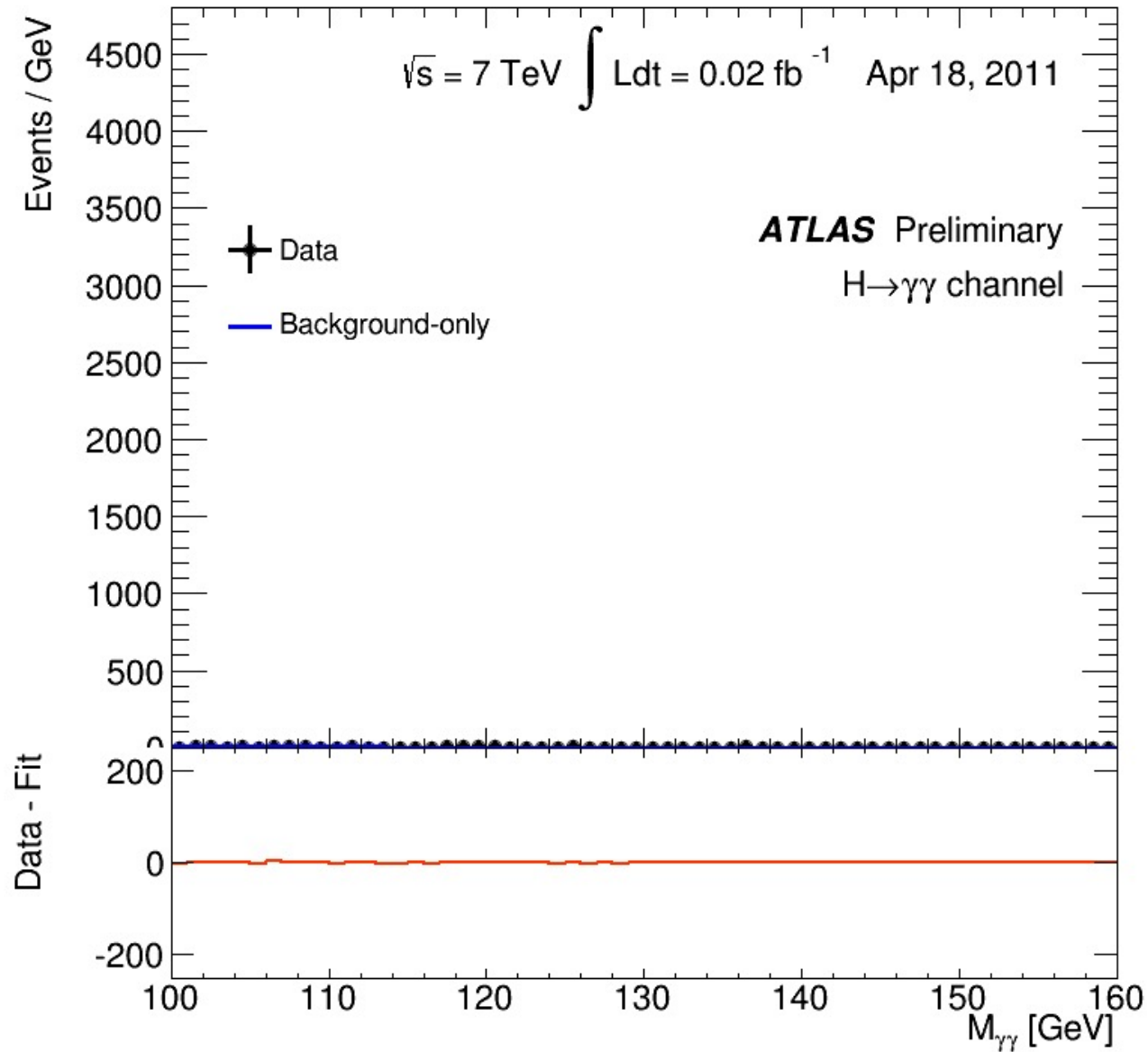
~~It's like looking for a needle in a haystack~~

~~It's like looking for a needle in 10000 haystacks~~

It's like looking for a piece of hay in 10000 haystacks



Looking for Higgs decaying to 2 photons



Spotlight on Birmingham contributions ...



**Higgs candidate
decaying to four
electrons ...**

- Birmingham-led analysis
- Triggered using electronics produced by Birmingham
- Shown using our ATLANTIS event display